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The Journal of HEREDITY

A monthly publication devoted to Plant Breeding Animal Breeding and Eugenics

NOVEMBER, 1924

THE SKUNK CABBAGE
J. MARION SHULL

SOLEDAD GARDEN AND ABORETUM
DAVID FAIRCHILD

PROPAGATION OF THE AIR PLANT
A REVIEW

IOJAP-STRIPED MAIZE
MERLE T. JENKINS

PUBLISHED BY THE
AMERICAN·GENETIC·ASSOCIATION
BALTIMORE, MD. AND WASHINGTON, D.C.

Volume XV Number 11

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The

Journal of Heredity

VOL. XV, No. 11 NOVEMBER, 1924

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The JOURNAL OF HEREDITY is published monthly by the

AMERICAN GENETIC ASSOCIATION

At 1918-32 Harford Avenue, Baltimore, Md., and

Victor Building, Washington, D. C.

Address communications regarding editorial matters and the business management of the Association to Room 306, Victor Building, Washington, D. C.

Entered as second class matter February 24, 1923, at the post office at Baltimore, Maryland. Acceptance for mailing at the special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized December 20, 1918. Contents copyrighted 1924 by the American Genetic Association. Reproduction of articles or parts of articles permitted only upon request, for a proper purpose, and provided due credit is given to the author and to the JOURNAL OF HEREDITY, Washington, D. C.

Date of Issue of This Number, December 30, 1924

$3.50 a Year, 35c the Copy

FLOWER SPATHES OF SKUNK CABBAGE

Frontispiece

The skunk cabbage is one of the most unconventional, or better, the most contrary of plants. It carries on many of its important functions backwards, as compared with the rest of the plant world,—flowering in the winter instead of in the summer, filling the air with a stench instead of a pleasant odor, growing *down* into the earth instead of *up* into the air. These and other habits of the plant that fit it to its chosen environment should give it especial interest to students of evolution and adaptation.

A METHUSELAH OF THE PLANT WORLD

The Skunk Cabbage

J. MARION SHULL
Chevy Chase, Maryland

SINCE the earliest mention by John Josselyn, Gent., in his work entitled *New England's Rarities Discovered,* dated 1670, the Skunk Cabbage, *Spathyema foetida,* has been an object of interest and speculation both to layman and botanist. Because of its very precocious blooming habit its flowers have often come and gone before there has been any real suggestion of spring to lure the nature-lover from his winter quarters, and he who would find it in bloom should explore the swamps and bogs where it naturally occurs, a couple of weeks before it seems possible that any vegetation should be astir. In fact, in the latitude of the District of Columbia, it is hardly even to be classed among the spring blooming flowers, for here it has been found in full bloom in November, in December, in January and in February. This fact has led some writers to describe it wrongly as sometimes blooming twice within one year, but the plant that blooms itself out in November or December does not bloom again the following spring, there being but a single annual blooming period, which may occur at any time from November to April.

A "Warm-Blooded" Plant

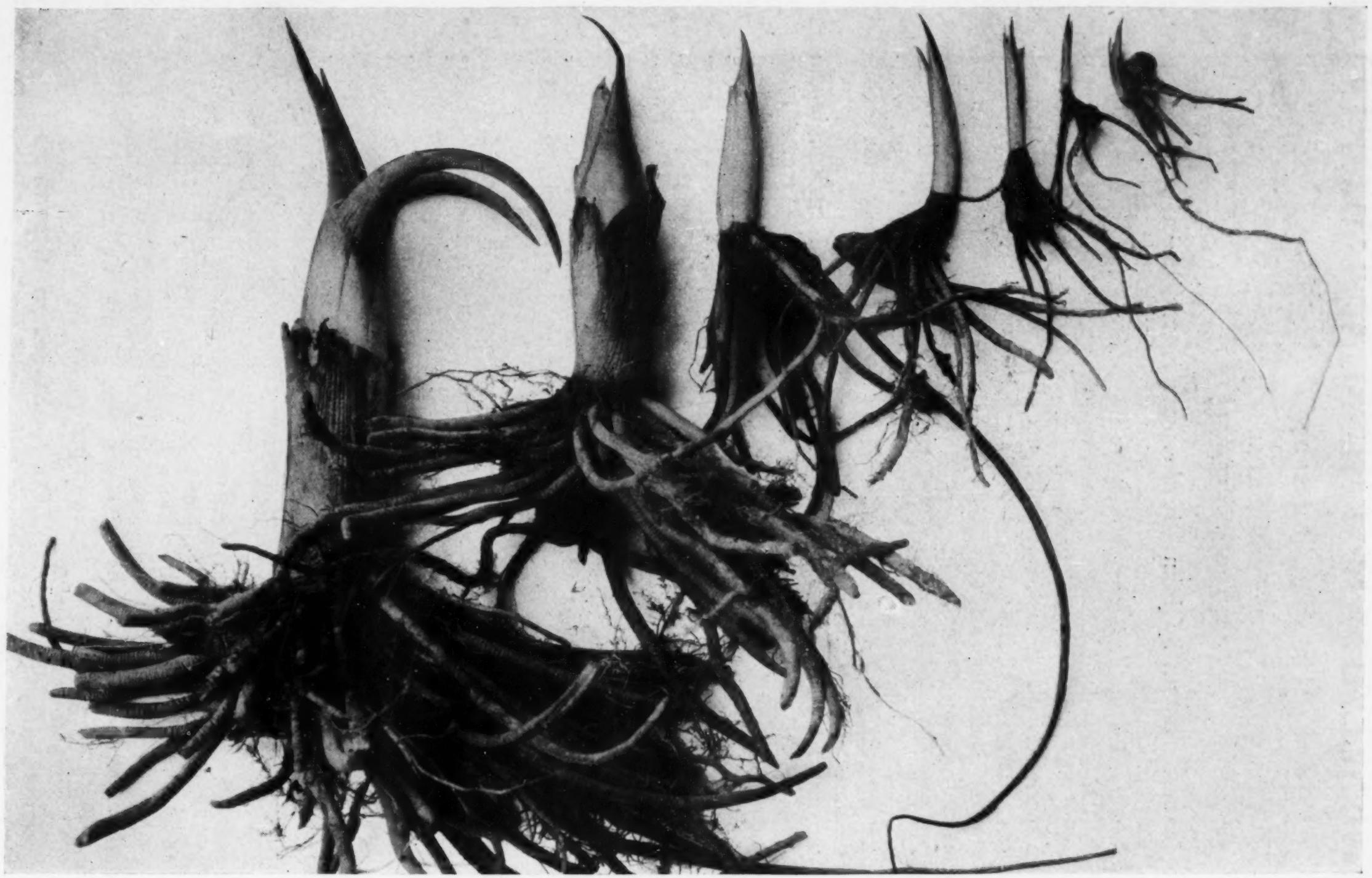
Naturally, those more adventurous plants that show themselves so early are apt to be severely nipped by later cold, for, while they are credited with possessing some warmth of their own, it is not sufficient to protect their flowering parts against such freezing as the winter brings. At times they may be found with a little ring of ice or snow melted away from around them in a manner and under circumstances that apparently cannot be explained except on the basis of internal heat, which furthermore is said to have been actually measured with the result that a temperature of some degrees higher than the cold air and soil around them is shown. But strange to say, while some are blooming in November and December, in response, as one would suppose, to an unwonted warmth of season, others apparently enjoying the same environment, basking in the same warm sunshine, remain quiescent, waiting for the safer and more stable conditions of settled spring.

After the quaint and curious bloom has disappeared and the warmth of spring bears more steadily on living things, the leafage thrusts upward at a prodigous rate, and soon, where there had been but the oddly colored, inconspicuous though highly odoriferous spathes, there now is found a great mass of light green leafage that appeals to the vision as well as to the olfactories, for the pungent, skunklike odor that accounts in part for its name is given out by leaf and flower alike.

About the middle of the summer the foliage in its turn has died away and again sharp eyes are needed to find the hiding place or locate the occasional large rough fruit, whose color assimilates so well to that of the dark, boggy soil in which it habitually grows. These fruits are filled with many large and fleshy seeds, but because they are without seed-coats and because the young plant within the seed is in all respects like a live lateral bud of the plant, with a number of rudimentary leaves already formed, the Skunk Cabbage has been described as viviparous.

Stages of Growth

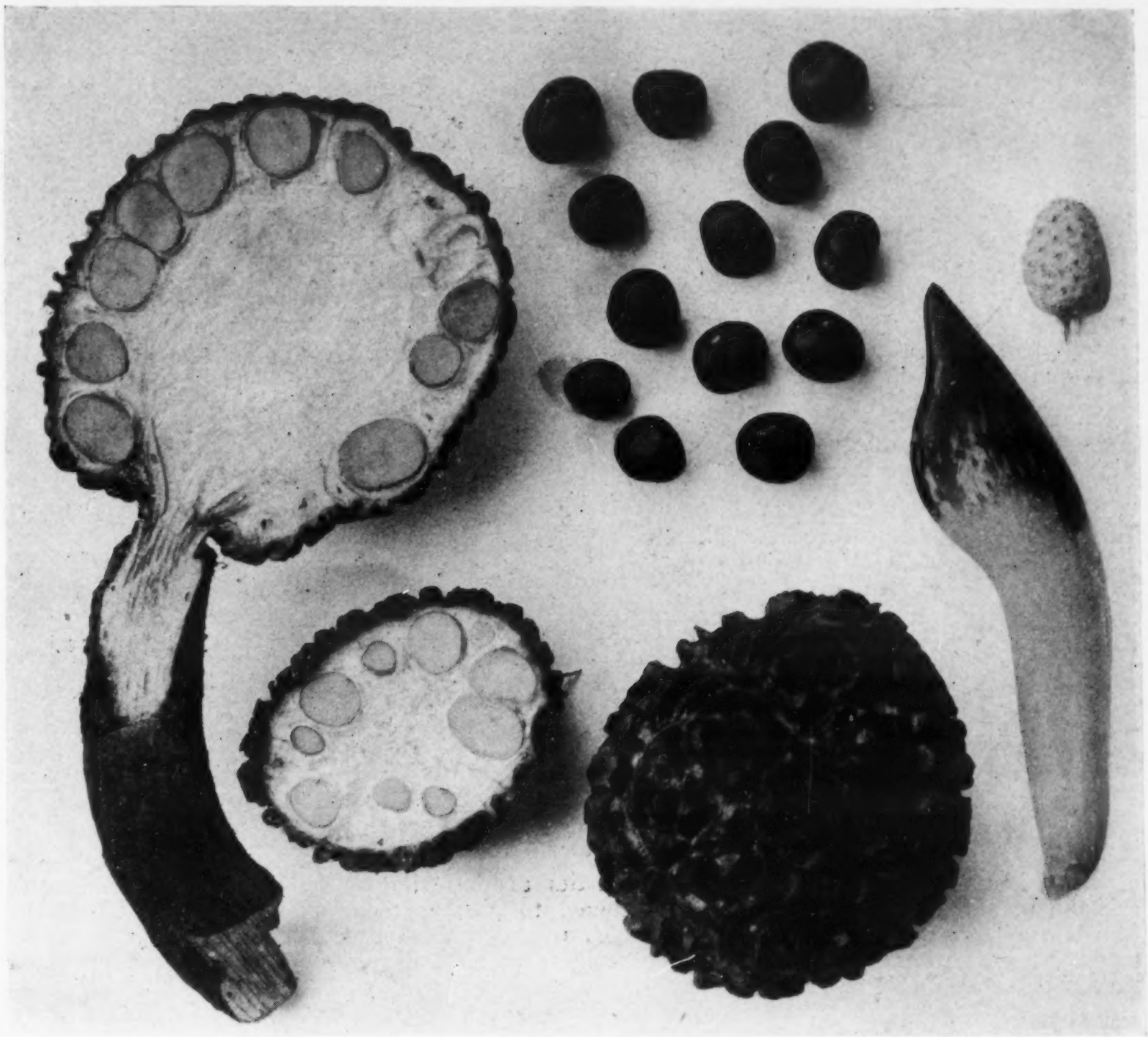
Notwithstanding the exceptionally rapid leafy growth of mature plants in spring, the young seedlings grow but



DOWNWARD THE SKUNK CABBAGE WINDS ITS WAYWARD WAY

Figure 1

The tips of the young leaves of these plants all remain at approximately the same level, regardless of the size or age of the plant. This is because the skunk cabbage grows in the opposite direction from most other plants, the stem being dragged down by the contraction of the long roots. It has been estimated that the average annual growth of a skunk cabbage plant is only from one to three millimeters, so that in reaching maturity a good many years must elapse. After the end of the rootstock has rotted away or been worn off, it is evidently impossible even to make a guess at the age of a plant, as the diameter of the root roes not increase after the plant reaches full size.



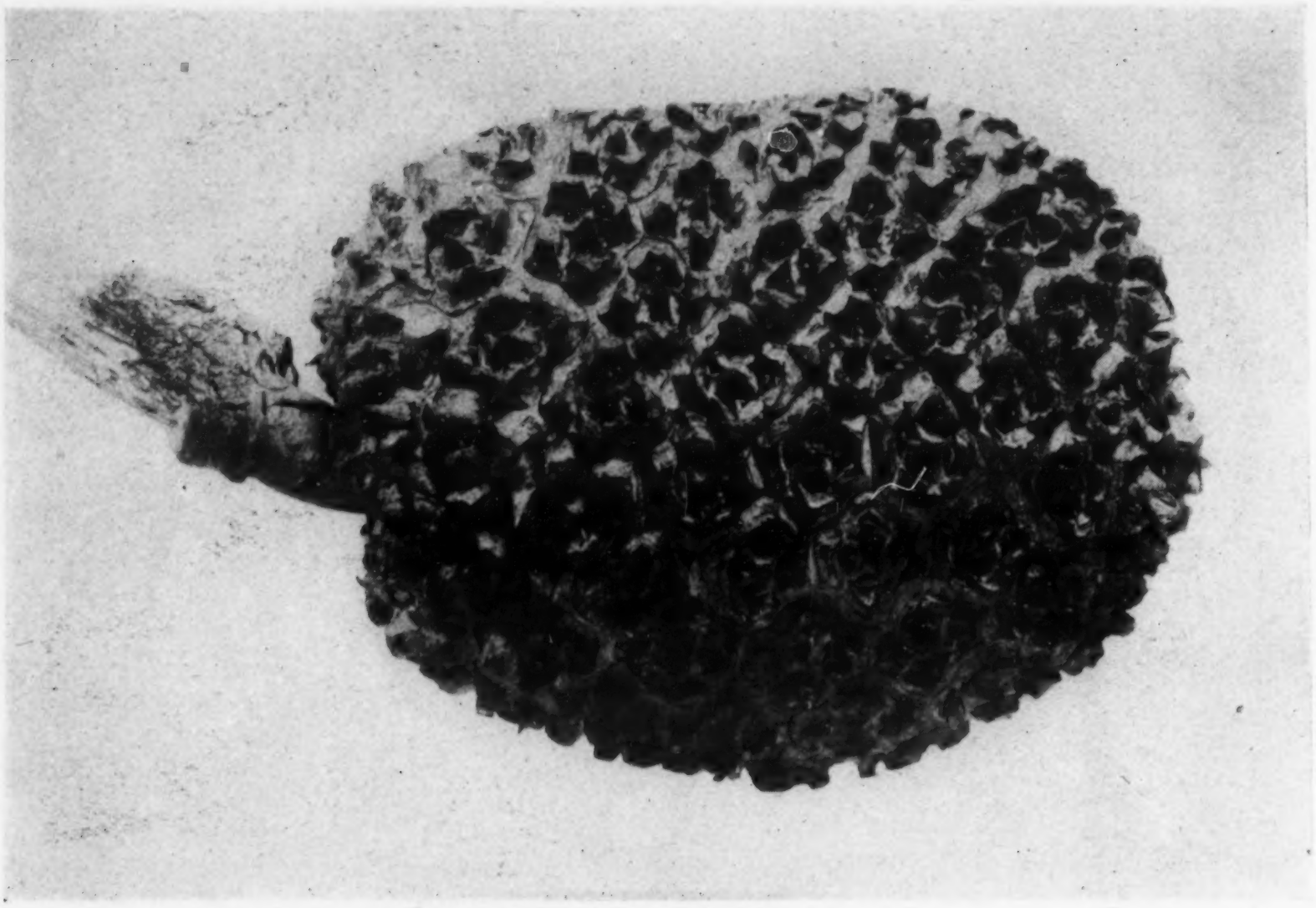
FRUIT, SEEDS, AND YOUNG FLOWER SPATHES

Figure 2

The seeds are crowded against each other at the surface of the fruit, giving them their irregular shape. The skunk cabbage has been described as viviparous because the young plant in the seed is already formed with several rudimentary leaflets like a lateral bud, and because the seeds have no seed coats.—Photograph by E. L. Crandall.

slowly and it takes a number of years to reach maturity, at which time the terminal bud is finally converted into a blooming spathe. This is a decidedly momentous period in the development of a young Skunk Cabbage. Hitherto life has been one continuous prosaic unfolding of leaf after leaf, each rolled up in precisely the same way, one completely inside the other, in what is characterized as the monopodial stage of its existence, broken only by the unavoidable periods of rest imposed by the changing seasons. Year by year strength and size have been attained until the crown is an inch or nearly so in diameter, and then the things of youth are put aside forever. The sympodial stage has at last begun and from this time on so long as life may last, with clock-like precision, the plant will produce two leaves and then a spathe, two leaves and then a spathe, and interesting to relate, the leaves that heretofore have always rolled in the same direction, now alternate, one rolled to the left and the next to the right.

meters, so that if the plant were cut off, it is evidently impossible even to make a guess at the age of a plant, as the diameter of the rootstock never reaches full size.



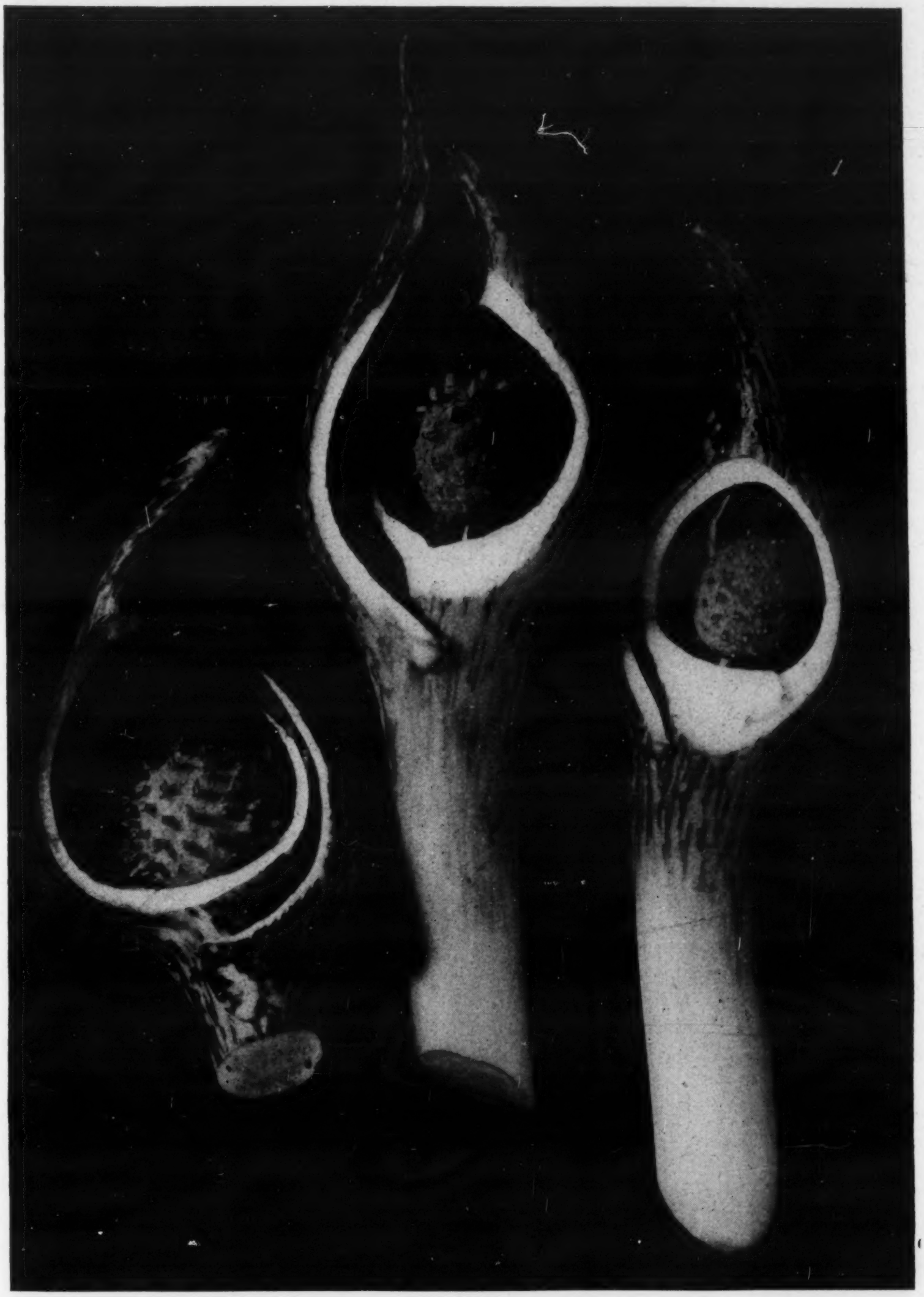
A LARGE FRUIT
Figure 3

In midsummer these greenish-brown fruits are all that is to be seen of the skunk cabbage plant. When one becomes accustomed to picking them out they are often to be found in great numbers on the floor of the swamp. A short time later they begin to disintegrate, liberating the seeds, which either take root on the spot or are scattered by flood waters or other agencies.

Is it mere chance or does some wisdom guide in ordering this change so beneficial to this denizen of the swamp, now grown so corpulent that but for this wise provision it would inevitably burst itself asunder or choke to death? So closely is each leaf wrapped round and round, and yet so urgent is the force of growth demanding free expansion, that some expedient must be found, and this reversal of successive windings answers perfectly, as one may demonstrate by rolling half a dozen strips of paper around each other in constantly alternating direction and then releasing them. Note how they open out without the slightest friction, all at once.

The perfect regularity of growth, two leaves and then an inflorescence, observed as fact, remains quite unexplained, unless it be that Nature would display for our encouragement some close relationship between longevity and a steady mode of life! Here certainly the two go hand in hand as I shall hope to show a little further on.

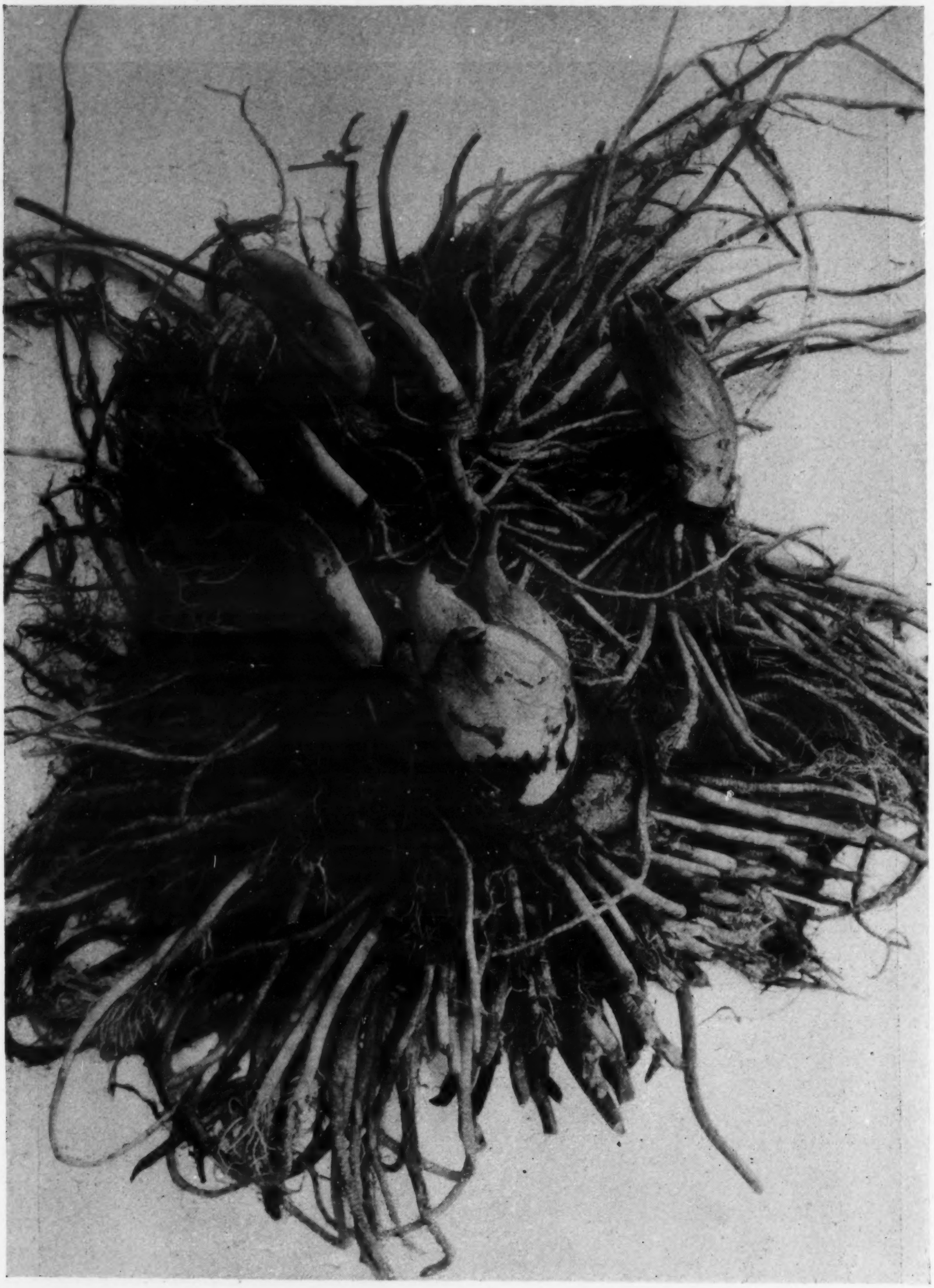
We might invest this plant with foresight, too, for possibly no other prepares so far in advance against its future needs. These flowering spathes that seem to leap from the ground at the first warm touch of spring, with such rapidity that one is tempted to compare them with the mushroom for speed of growth, in reality have been a long time on the way, often as much as nearly three years in the making, nursed at the heart of the mother plant. More than this, as if with foreknowledge of an insufficient food supply for all, a goodly half, or more, are choked to death in infancy that the remaining ones may be well fed and come to full



FLOWERS OF SKUNK CABBAGE

Figure 4

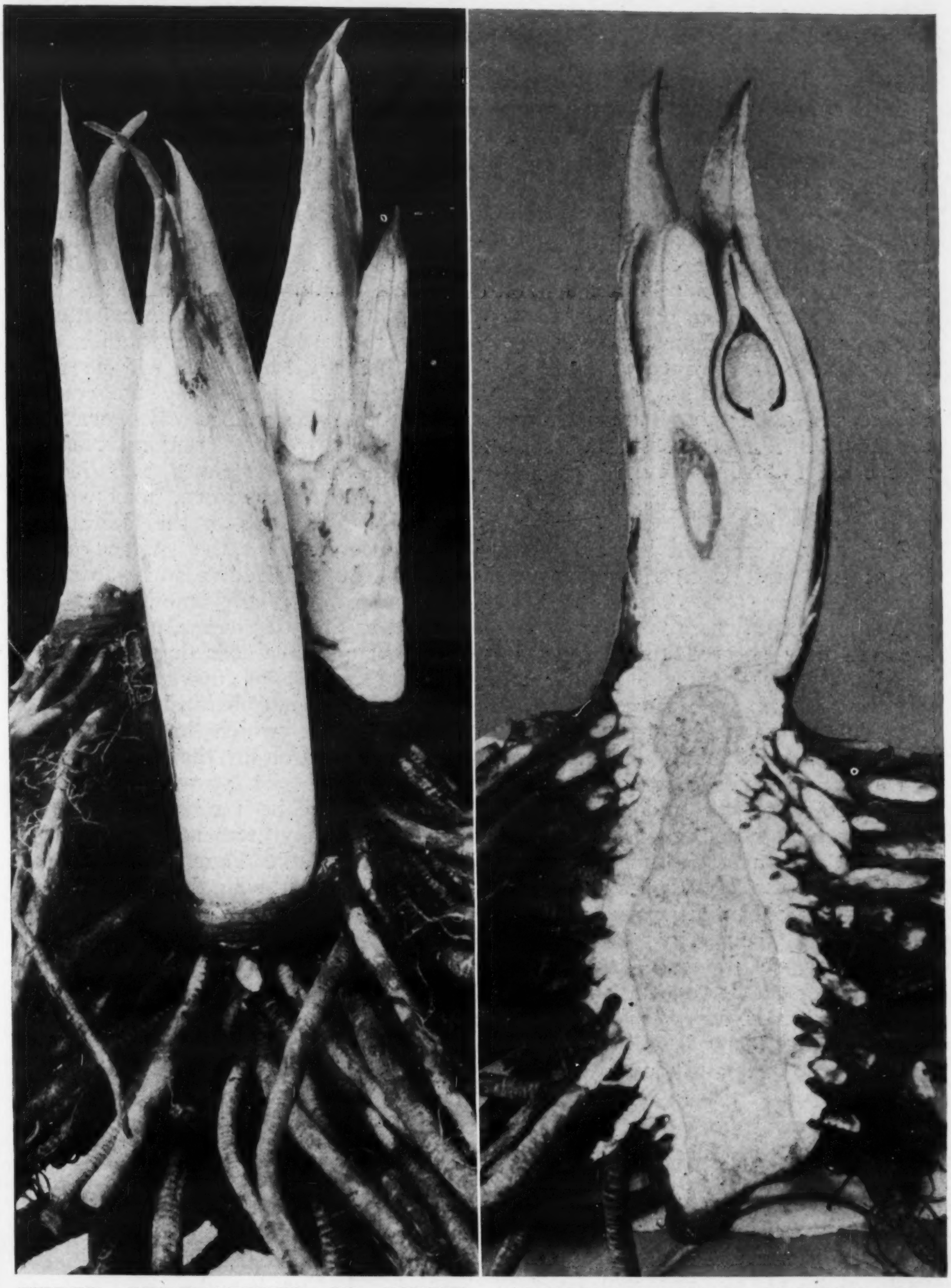
These were photographed on January 22, 1916, a time of year when frost flowers are the only others likely to be found in bloom.



A SKUNK CABBAGE FAMILY GROUP

Figure 5

Just as dug out of the swamp. The large plant is a patriarch of indefinite age, its tap root being worn off at the bottom, so that an estimate as to the number of its years is impossible.—Photograph by E. L. Crandall.



THREE GENERATIONS OF SKUNK CABBAGE

Figure 6

When the young plant becomes old enough to fruit, many of the seeds take root in its immediate vicinity. The young seedlings send down their roots to become entangled with those of the parent plant, and as the years go by the whole group moves downward together.—Photograph by E. L. Crandall.

LONGITITUDINAL SECTION OF PLANT

Figure 7

This section though a mature skunk cabbage shows the large rootstock which is dragged down by the contraction of the scores of lateral roots. The lower end has been broken or rotted off, so that it is not possible even to guess how long the entire root might have been.—Photograph by E. L. Crandall.

fruition. For large as are the leaves, and they are sometimes as much as two feet in diameter, they cannot in their few brief months of activity prepare sufficient food to mature so many large and heavy-seeded fruits as would result if all were given equal opportunity. Removing carefully the outer scales or half-developed leaves from leaf buds found in early spring, reveals these partially developed spathes, done to death for the welfare of those that more fortunately remain, but farther in all are still alive though destined, part of them, to die as these have done, before the following spring.

Age of the Plants

And now what shall be said of the age of this most interesting of plants? That none can tell. There are some men who skillfully contrive to hide their age and may succeed for a time, but here is a member of the plant world that conceals its age successfully not only for a time but for all time. A tree may soar in height until no longer able to transport its vitalizing forces higher up and so must stop and stagnate and die at last, and one may open up its heart and reckon the full measure of its years. But the Skunk Cabbage normally grows only at the summit as do the palms. Then why not like the palms, soar up to such great height that finally the storm winds gain the mastery and make an end of it? Again Dame Nature has bestowed a gift denied to the oaks and palms and other lordly trees. Each year a circle of crisp white roots reach down diagonally from the crown, burying themselves deep in the rich black soil. When anchored firmly they begin contracting and so with steady pull drag down the entire trunk as fast as it mounts upward. To find the lower extremity of this trunk, that really backs downward instead of pushing up into the air, one frequently must dig quite deep, and then the lower end will be found rounded and polished by the constant thrust into the soil, slowly worn away by the never-ceasing friction. Near the very bottom, sometimes two feet or more below the crown, may still be seen the leaf scars or the lateral buds that once grew at the surface of the ground, buds still alive and waiting for an opportunity to renew the plant should any mishap overtake the growing top. Plants have been dug whose years were reckoned at upwards of three score and ten, but obviously that portion of the trunk which has been worn away by friction in the deeper soil is quite beyond the power of estimate and may have been much greater than that which now remains, and thus it happens that the Skunk Cabbage that is seen today growing in unpretentiousness in any bog may possibly outrival the sturdiest of the oaks in point of age, may not improbably have occupied that very spot long years before Columbus set foot upon our shores and may continue there a thousand years and more from now if only the fates be kind.

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THE SOLEDAD GARDEN AND ARBORETUM

The Harvard Biological Institute in Cuba (Atkins Foundation) on Soledad Estate

DAVID FAIRCHILD

IF you want to breed plants why not go where the plants grow all the year 'round and not merely in the summer time? I have seen the plant-breeding greenhouses on the plains of the Dakotas and Minnesota where, when the ground is white with snow, Hansen and Harolson force their Siberian plums and almonds into bloom, and cross-pollinate them. These institutions, which deserve the support of the great commonwealth which they serve, have always reminded me of astronomical observatories because the plants can only be crossed once a year, just as an astronomer can only make certain astronomical readings once a year. All the work of years, growing the plants from seed, potting them, repotting them and establishing them in tubs has to be made in prepararation for this single event—the cross-pollination—the results of which will only be apparent many years later.

To cut in half the time in which to bring a plant into flower, and then to halve the long wait to find what the seed has produced, is equivalent, it seems to me, at least to doubling the life of the hybridizer. Whether Mr. Robert M. Grey saw this fact when he accepted the invitation of Mr. Edwin F. Atkins, of Boston, the owner of large sugar estates on the South coast of Cuba, I do not know, but it is evident now that the meeting of these two men and their association for twenty-five years was an event of which it is high time the plant breeders of the world should know. It has resulted in the building of a remarkable arboretum of tropical trees and shrubs, and the production of a number of plant hybrids which indicate the possibilities of tropical horticulture in no uncertain way.

Beginnings of the Garden

I think the meeting of these two men was twenty-five years ago, but when I looked up at the tropical trees in the arboretum, it seemed as if a half century or more must have passed since they met. Perhaps man shortens his life in the tropics, but if we measure our lives in terms of the growth of the trees, he lengthens it—for after all, do we not measure our age by the growth of living things and the changes which time makes in the landscape around us?

So Mr. Grey, a plant breeder and real lover of plants, found himself located in a valley with sugar cane fields all about him, and began, plantsman-fashion, to gather together the species of plants which interested him. Without really knowing it, I think, both Mr. Atkins, who has continuously and interestedly supported his plant breeder, and Mr. Grey, who has so indefatigably worked with living plants, have made a tropical arboretum of great value to the world. So quietly have these things gone on that although I have been spending my winters in Florida since 1914, I had never visited Soledad, and when a telephone call same from Havana from Dr. Thomas Barbour of Cambridge, urging me to visit it with him, had no idea what I was going to see. I had met Mr. and Mrs. Atkins and Mr. Grey in Washington, and knew they were much

A NEW ENGLAND WOMAN IN HER TROPICAL GARDEN

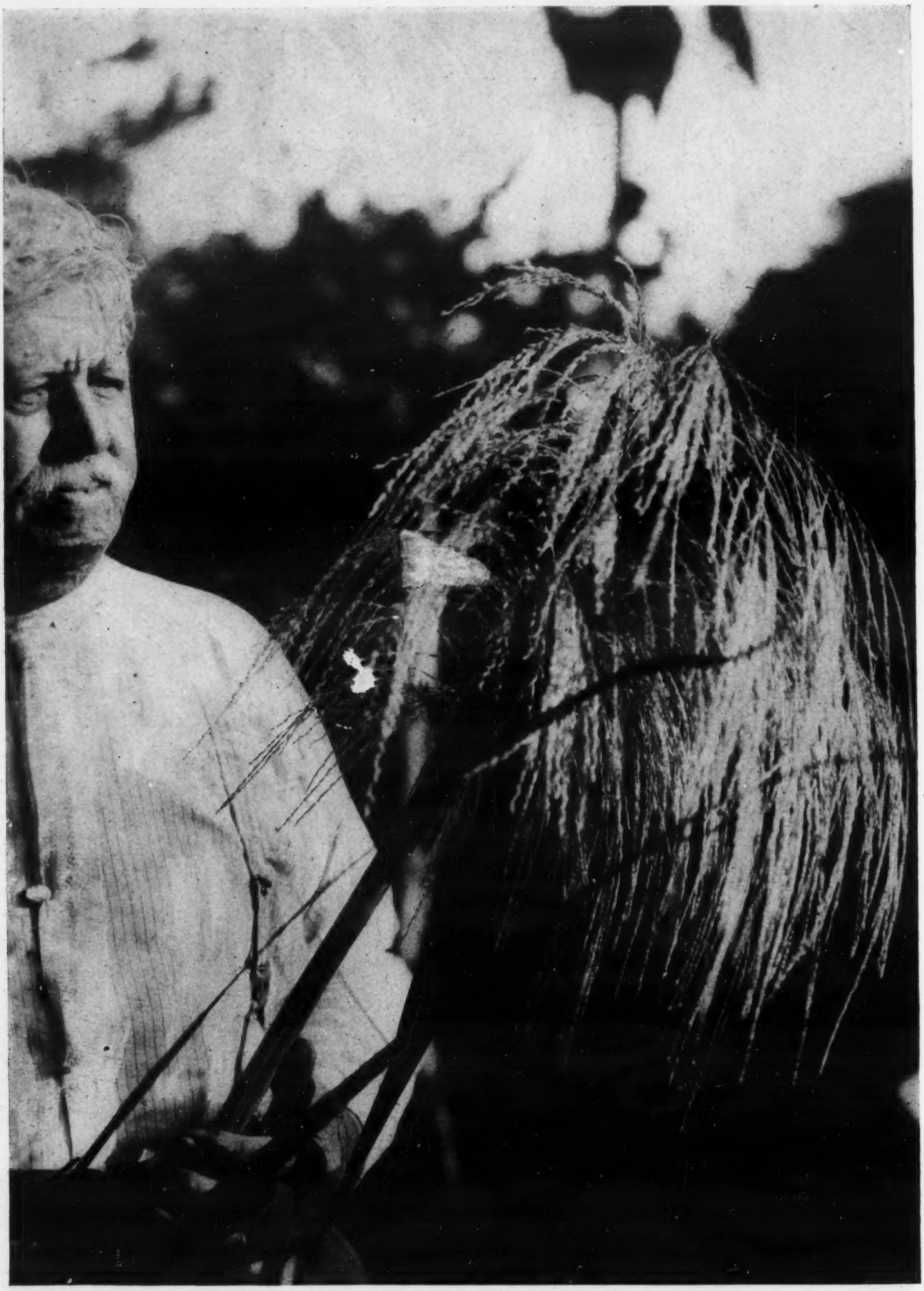
Figure 8

Mrs. Atkins holding in her hands the delicate, fragrant blooms of the African liana which was named after the great Portuguese poet, Camoens. Beside her are the golden yellow fruits of *Garcinia tinctoria,* a relative of the mangosteen which thrives in Soledad garden.

THE OWNER OF SOLEDAD

Figure 9

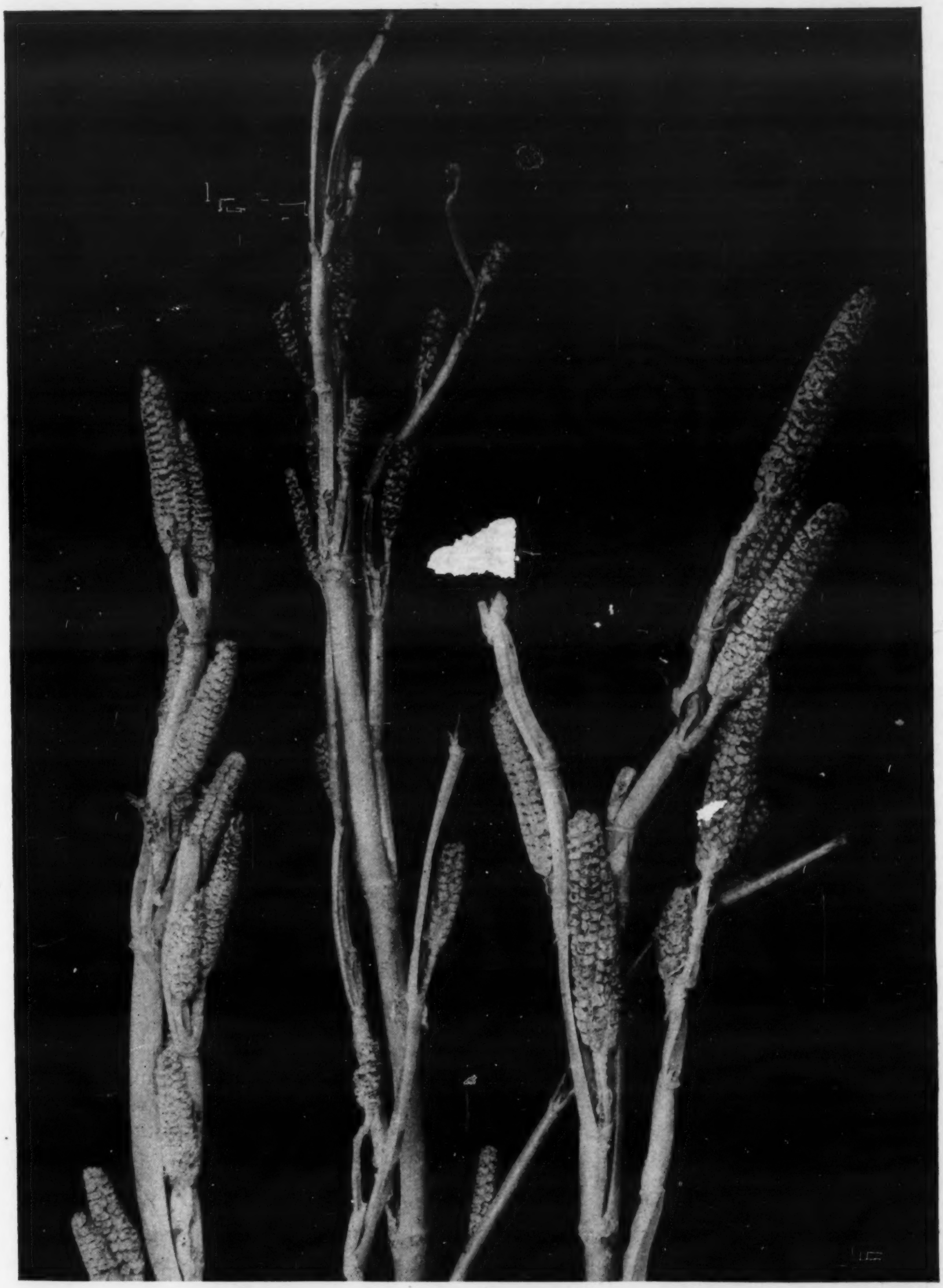
Mr. Atkins' belief in the commercial value of Tropical Agriculture has built him a fortune, part of which he is devoting to the furtherance of discoveries in the field of tropical biology. The plant beside which he is seated is a beautiful specimen of the Travelors' tree of Madagascar, a relative of the Banana, which furnishes a refreshing juice from the cut leaf spathes.



THE PLANT BREEDER AT SOLEDAD

Figure 10

Mr. Grey holding an "Arrow" of one of his best selected sugar cane varieties—his number 4120—which tests eighteen per cent sucrose and has been growing where it now is for five years without any fertilizer whatever. Few who have not grown plants realize the amount of toil and the chances of failure which attend the introduction of superior varieties. It is a pity that usually so little financial reward goes to those whose undying perseverence makes possible the production of improved types, which are the basis of prosperity in every progressive agricultural region.



CURIOUS RESULTS OF HYBRIDIZATION

Figure 11

Three types of inflorescence on a hybrid between the tropical grass, Teosinte, which was used as the pollen parent, and an Argentine variety of maize. The original hybrid was twice back-crossed on the Argentine maize. This is one of the many plant breeding projects which Mr. Grey has been carrying on at Soledad.

A LILY POND AT SOLEDAD

Figure 12

The hybrid lilies of the great plant breeder, Marliac, are set off by the background of Pandanus, Bamboos, Royal Palms, and the giant trunk of a Ceiba tree, such a striking feature of the great gardens of the East Indies.

interested in tropical plants, and I had heard from Professor Oakes Ames, of Harvard, of the plant collection which was growing up there, but I had not thought of it as an arboretum. So when in the early morning, together with Mr. and Mrs. Atkins and Dr. Barbour, I first walked under the giant *Ficus* which shades the unpretentious entrance to this delightful garden, I was quite taken by surprise with its luxuriance. Had I properly appreciated, however, the personality of Mr. Grey, who stepped out of the tiny greenhouse by the garden gate, I should have known that he would do things in Cuba like those which that great man, the late Jackson Dawson, did in the Arnold Arboretum in Boston, for he has an insatiable passion for plants and remembers their behavior as easily and accurately as a fond mother remembers the actions of her first child.

It is one thing to wander about through a collection of trees so thoroughly etiquetted with glaring white labels that the eye with difficulty can tear itself away from the patches of white, and quite another to accompany the man who has watched every tree in it grow from a seed or cutting into what it now is—a stately palm, a tropical fruit tree, or a flowering liana which climbs to the highest tree tops.

This garden of Soledad is not a logically planned out and blueprint executed aboretum, but such a garden as people of taste, working with a born

plantsman, might make anywhere in the real tropics, but which they seldom do. It covers now about thirty acres of rolling land about a mile from the Soledad *Central,* or sugar mill, and the charming old building and gardens where the Atkins have made their home for many years. These thirty acres are already filled with trees and shrubs, so the sugar lands adjoining and the remains of a virgin forest near by are to be included in the garden, to make room for the hundreds of other tropical trees which are being added each year to the collection.

Impression of the Garden

As there is nothing which fails to give the spirit of an aboretum quite so fully as a card catalogue of the names of the plants which are in it, I shall avoid this obvious way of describing a collection of trees, and attempt to put down my impressions and compare them with those made by the great tropical gardens in Trinidad, Ceylon, and Java—now rather dimmed by the passing years. The glory of those century-old gardens cannot, of course, be approached in the short time in which Soledad has been growing, and yet, we wandered in the early morning along the winding pathway by the lily pond, where hundreds of gorgeous Marliac hybrid pond lilies were in bloom, I could not help comparing it with that in Buitenzorg, in which the Governor General's residence is reflected between the Victoria Regia lily pads. The setting of this pond is tropical. The *Ceiba pentandra* has the same tall, graceful light-grey trunk here that it has in Java, though its branches do not stand out at right angles as they do there—suggesting a variation which has been perpetuated among the oriental trees of this species since its introduction. The rank-growing *Alpinias* and *Heliconias* from Central America; the giant travelers' tree from Madagascar; the tall clump of tropical bamboo; the fish tail palm, *Martinezia caryotaefolia;* and the immense clump of *Pandanus veitchii,* seem quite as happy and contended here as in those oriental gardens, while the columnar Royal Palms which form the uppermost sky line everywhere, remind me of that newly planted young avenue of this same species which Dr. Treub, the Director, once showed me with great pride in the Buitenzorg Gardens in 1896—the first I had ever seen.

No time of day, and no temperature conditions can quite compare with the period from six to eight o'clock in the morning in a tropical garden, and I shall never forget my impressions as the group of us hurried from one plant to another, photographing each luxuriant specimen, the first morning of my stay at Soledad. The brilliant pink stamens of that native West Indian tree, *Bombax barrigon,* look like pin cushions on the leafless branches, for some tropical trees flower before the leaves come out, just as our flowering cherries and dogwoods do. The evergreen-leaved *Magnolia grandiflora,* with the tropical orchid *Broughtonia sanguinea,* in its branches, reminds us that certain trees of northern latitudes which one thinks of as hardy, live perfectly well in the tropics, where they bloom in March.

Relatives of the Mangosteen

I have always been fascinated by the deep green leaves of the mangosteen and its relatives. There is something in them reminiscent of the oriental tropics, in fact, Java would hardly be Java without them, and when, down in a low spot near the trail, I saw a magnificent tree from Cochin China—representative of this great genus, *Garcinia*—and farther on, loaded with golden yellow fruit as large as peaches, one of *Garcinia tinctoria,* and between the two the somewhat less tropical *Garcinia spicata,* which is used as a windbreak in the Riukiu Islands—all with leaves of a superb dark green, almost black, I could not avoid the impression that I was in the real rain-forest trop-

THE NEW LABORATORY AT SOLEDAD

Figure 13

This new laboratory for the study of tropical life, which has just been completed by Mr. Atkins, has now been placed at the disposal of research men.

ics of the old world. Why it is that these superb trees have played such a minor role in the botanic gardens of the world I do not understand, for there are one hundred species or more, and over thirty of them are reported to have edible fruits. It gave me a thrill of personal pride to learn that these three species were growing where they were, because I had sent them to Mr. Grey some years ago, as seeds or potted plants. I could not resist gathering some of the yellow fruits and eating them, sour as they were, for that dear old botanist, Medley Wood, of the Botanic Garden in Durban, once told me years ago that the fruits of this same species which grew in his garden then, formed a favorite breakfast dish of one of the Governors of Natal. This introduction to the edible qualities of the *Garcinia tinctoria* fruits led to a wider trial of it by Mrs. Atkins, resulting in the usual varying opinions of her guests. Some people like new things and others do not.

Mr. Grey had written me that the little plant of that rare climbing Legume named after Camoens, the great Portuguese poet,—*Camoensia maxima* —which I sent him years ago, had grown. In fact, he had even sent me seeds of it, but its luxuriance of foliage, even though there were only a few blooms open, was a great surprise to me. It has the distinction of having the largest flowers of any member of the great order Leguminosae. To me it has always seemed to be the real ghost-flower of the tropics, with its great white petals edged with old gold, and the faint but delicate perfume.

This was the first plunge into the garden, and its impressions will never fade. Later a serious study of the trees and shrubs was made, and my note books are full of memoranda of the interviews with Mr. Grey, one of the very first real plant breeders of long experience in the tropics that I have ever known. I tried to get an idea an the range of plants with which

THOUSANDS OF PINK STAMENS

Figure 14

The brilliant pink stamens of this flower, *Bombax barrigon,* make it one of the showiest objects in the Soledad garden in March. The tree is leafless during the blooming period and the stems contrast strikingly with the green bark.

he had been working during the thousands of bright mornings of the twenty-five years he has been making this marvelous collection almost as a pastime from his regular work.

Selection of Sugar-cane and Other Experiments

He came to Soledad to select sugar canes at a time when even the idea of there being such things as sugar cane seed and seedlings was new. His record books, filled with thousands of entries, show what a vast number of selections he has made and tested for their sugar content and their resistance to the various pests and diseases to which sugar cane is subject. He feels, as it is natural that a good plant grower would feel, that the mosaic disease is correlated with and is at its worst where conditions are unfavorable to the growth of the cane itself. Selection and variety crossings form, as might be expected, the bulk of this great work which he has done. Hybridization experiments begun later have not yet gone far enough to be written about, and when it appears that most of these new high-yielding sorts are

FLOWERS OF CAMOENS' LIANA

Figure 15

This is the largest flower produced by any Leguminous plant.

not yet used commercially in comparison with the Crystallina cane, it should not be forgotten that to introduce a new variety of any plant into a staple culture where expensive machinery is employed, requires much time and necessitates many changes, and, to start with, the variety must excel in more respects than mere resistances to disease.

Mr. Grey's experiments in crossing maize with teosinte and crossing back on maize again for several generations produced some curious branching forms with strange appearing ears—of promise only perhaps for fodder purposes, but interesting to those geneticists, who view maize as of hybrid origin.

His selection from 500 seeds of the naval orange, the result of hand pollination of flowers with their own pollen, is as delicious as any orange I ever ate, a distinctive improvement, he believes, over the Washington Naval as one sees it in Florida or Cuba. He has propagated from a sporting branch of a Valencia orange tree which he observed had green fruit on it long after the fruit on the rest of tree was ripe, and secured a late Valencia which holds its fruit long after the regular Valencia season.

He has crossed a native fiber-filled mango with the fiberless East Indian Sandersha, and has obtained a variety which is intermediate between the two. He has done some work with the grapefruit and the various anonas, but little with avocados. He has done just what a very busy man who loves to work with plant varieties would do —crossed the species and varieties which flowered around him. By doing this he has, in my opinion, opened the door to the geneticists into a vast and fascinating field for discovery, that will lead to the production of amazing, productive, delicious, and valuable new varieties of tropical plants, which, as the exploitation of the Torrid Zone progress, will become of the greatest commercial importance. As with our northern horticulture, so with that of the tropics—it must be based upon varieties and varieties are the result of selection and plant breeding.

The impression of Soledad as a happy combination of circumstances must include the background of Harvard personalities without which it is not probable that such an institution would have come into existence. The stimulus given in its early days by Dr. George L. Goodale, Professor of Economic Botany; the many visits and close study of its problems by Professor Oakes Ames, and the recent steps which Mr. and Mrs. Atkins have taken to make Soledad a permanent place where research students in biology can study—since the formation of an Administration Committee of Harvard professors—deserve to be known to all who are interested in genetics.

The new and beautifully equipped laboratory called "Harvard House" which Mr. and Mrs. Atkins have built, has just been opened to advanced reseach workers, and the charming hospitality of Soledad, which the many scientific men who have enjoyed it will always remember, is now being extended to all accredited scientific workers who wish to take advantage of its many opportunities. Living quarters have been provided in the laboratory,* which will bring a stay at the Soledad Garden within the range of the finances of professional geneticists, and beyond doubt the development of this tropical institution will have a most stimulating effect upon the minds of the younger men of America who realize the need of enlarging their horizon of acquaintance with living organisms.

May the creators of the Soledad Institution be spared to the world for many years until they have made its foundations broad and secure in support of research in the vast field of the tropics.

*For information regarding the facilities offered at the Harvard Laboratory at Soledad, any member of the Committee in charge may be addressed. The members are Prof. W. M. Wheeler, Prof. Oakes Ames and Dr. Thomas Barbour, all of Harvard University.

SEX OF OVER-TERM CALVES

J. J. Hooper and J. W. Nutter
University of Kentucky

MANY live stock breeders assume that if a cow carries her calf over a more extended period than 283 days of pregnancy, that the calf will usually be of the male sex.

To determine whether this belief is true or not, we have studied the breeding records kept in connection with the dairy herd at the Kentucky Agricultural Experiment Station, the records covering a period of approximately twenty years, and embracing six hundred gestations. From this mass of data only gestation periods that exceeded the usual period by at least five days are used. In this way data has been secured on the following forty-four cows and calves:

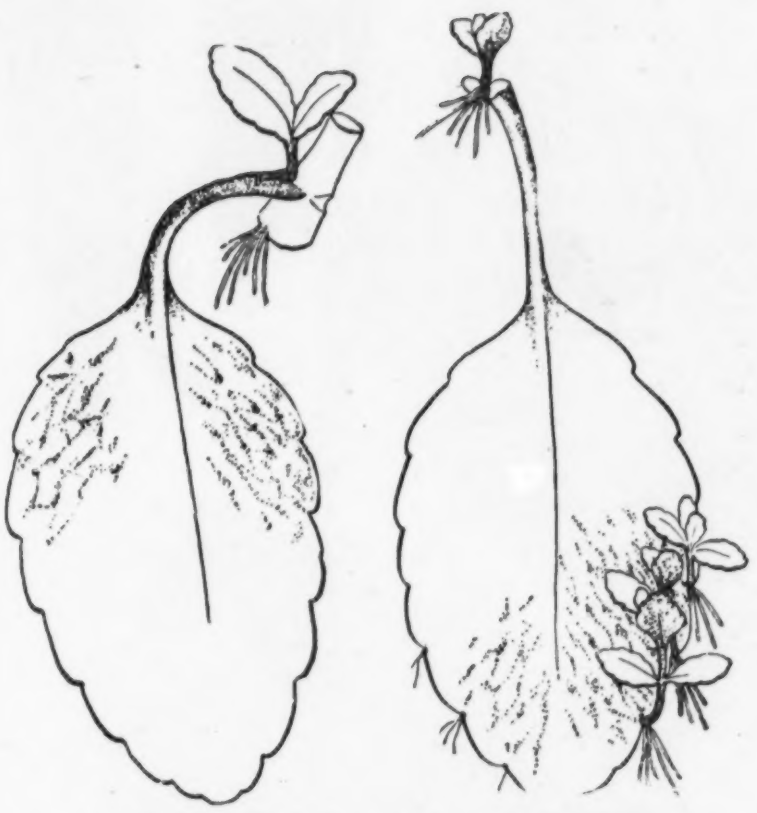
Sex of Calves Carried More Than 283 Days.

Cow	*No. Days Over 283*	*Sex of Calf*	*Cow*	*No. Days Over 283*	*Sex of Calf*
1	7	Heifer	23	6	Heifer
2	6	Bull	24	6	Heifer
3	7	Bull	25	11	Heifer
4	14	Heifer	26	10	Heifer
5	6	Bull	27	8	Bull
6	11	Bull	28	7	Bull
7	17	Heifer	29	6	Heifer
8	7	Heifer	30	5	Bull
9	14	Bull	31	6	Bull
10	10	Bull	32	6	Bull
11	7	Bull	33	6	Bull
12	10	Bull	34	6	Bull
13	5	Bull	35	6	Bull
14	7	Heifer	36	5	Heifer
15	7	Heifer	37	10	Bull
16	12	Bull	38	5	Bull
17	5	Heifer	39	5	Heifer
18	6	Bull	40	9	Heifer
19	6	Bull	41	8	Heifer
20	8	Heifer	42	6	Bull
21	5	Heifer	43	7	Bull
22	6	Bull	44	6	Bull

It is found that the above forty-four cows exceeded the usual gestation period from five to seventeen days, and that they gave birth to forty-four calves, twenty-six of which were bulls (59 per cent) and eighteen of which were heifers (41 per cent). We believe that this indicates in a general way what may be anticipated when the cow carries her calf several days beyond the usual period of gestation.

VEGETATIVE PROPAGATION OF BRYOPHYLLUM

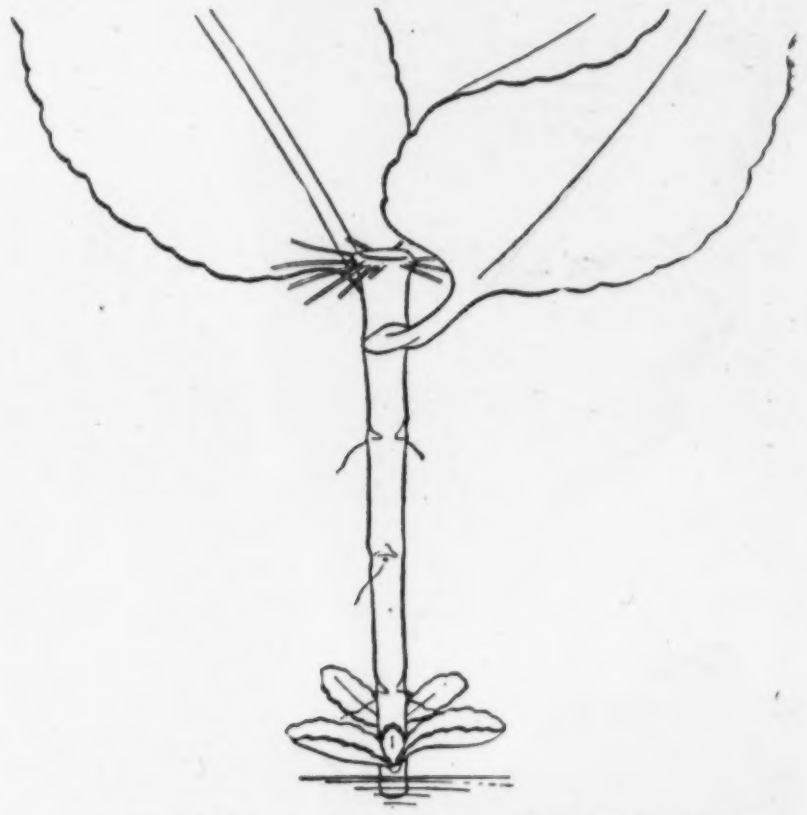
A Review



MOVEMENT OF PIGMENT

Figure 16

Some of the leaves of Bryophyllum are colored with a reddish pigment represented here by stippling. In the leaf on the left the pigment has migrated into the petiole and toward the base of the leaf, that is, toward the most active growth region. In the other leaf it has moved toward the right hand edge of the leaf, where the new shoots are forming.



POLARITY NOT AFFECTED BY GRAVITY

Figure 17

This stem was suspended in water upside down, but roots are formed at its upper end and leaves at its lower end, in spite of gravitational influence. Bryophyllum is so hard to kill that the large number of laboratory experiments to which it can be subjected makes it ideal for the study of vegetation reproduction. From Loeb's *Regeneration.*

BRYOPHYLLUM is a succulent tropical herb of the family Crassulaceae, and is one of the few plants that are able to produce vegetative buds from the leaf tissue. The new shoots arise at special points indicated by shallow notches of the leaf-margins. Also, the tissues of Bryophyllum are very tenacious of life, which greatly facilitates laboratory study of the habits and reactions of the plant to different conditions of growth. A plant that is so difficult to kill can be subjected to many tests that most species would not endure. Bryophyllum is often known as the "air plant" because it can be hung up by a string, and forms new shoots in that condition. The specific name *pinnatum* is older than *calycinum,* though the latter is more generally current. The leaves are either simple or compound, both forms of leaves occurring commonly and rather indiscriminately on normal well-grown plants in the tropics, though only simple leaves may be found on stunted laboratory speciments.

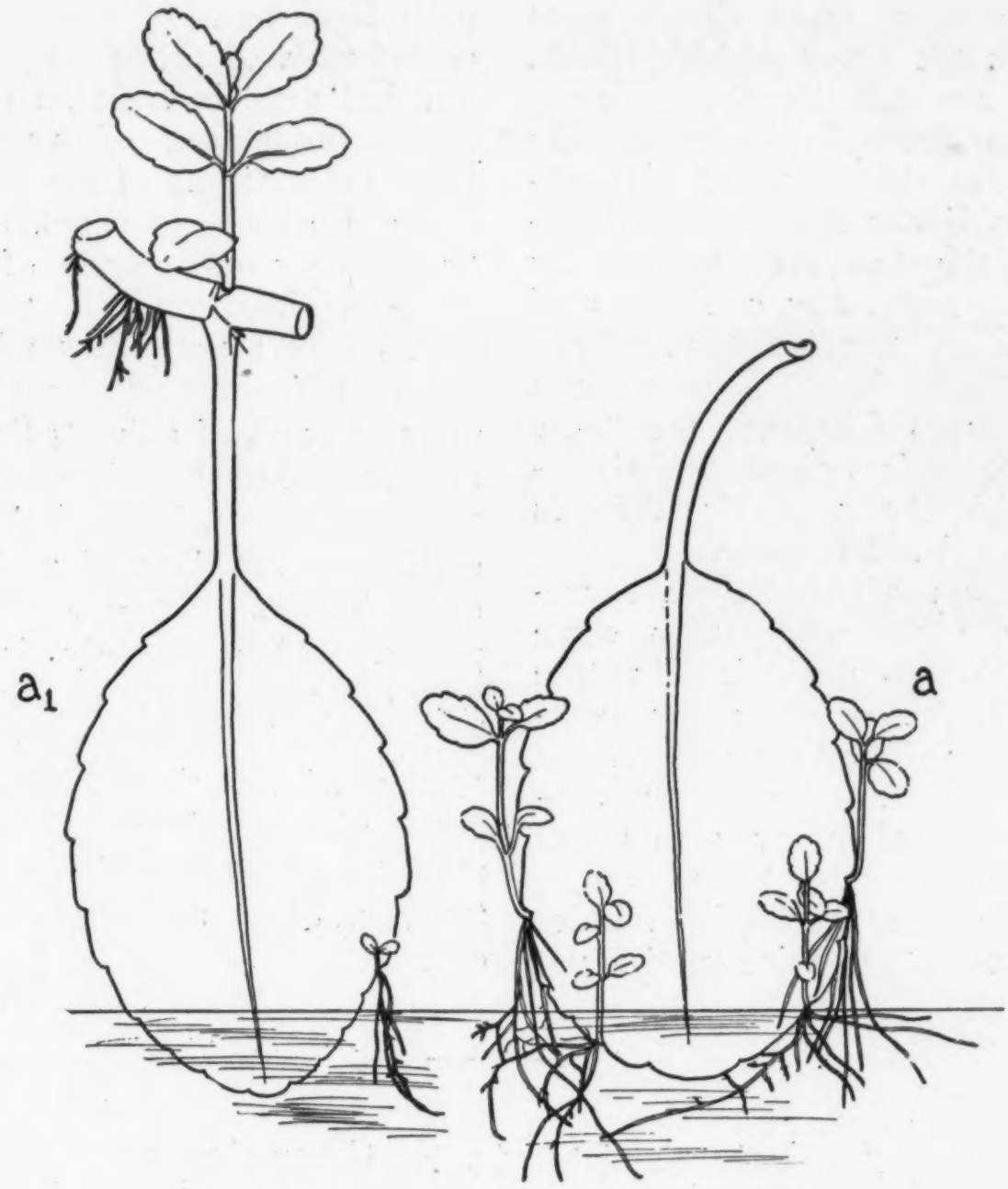
In Jacques Loeb's last book,* large numbers of experiments with cuttings

*REGENERATION, From a physico-chemical point of view, by JACQUES LOEB, late Member of the Rockefeller Institute for Medical Research. pp. 1x+144. Price, $3. McGraw-Hill Book Co., New York. 1924.

LEAF AND FLOWERS OF THE AIR PLANT

Figure 18

Bryophyllum is a plant, native in tropical America, which has the peculiarity of producing new plants from the notches in the leaves. In fact, new shoots are produced even when the leaves are hung up by a string,—hence the name, "air plant."



INHIBITING EFFECT OF A PIECE OF STEM

Figure 19

Two sister leaves are kept for a period of seven weeks under identical conditions. One has a piece of stem attached, the other has not. The inhibiting effect of the stem upon growth is evident. From Loeb's *Regeneration.*

of various sizes and shapes in varied positions and exposures are described and illustrated with excellent diagramatic drawings, so that it may be considered as a manual of laboratory technique in this class of experiments, as well as a monograph on the physiology of vegetative reproduction and growth of new shoots in Bryophyllum. No doubt the use of Bryophyllum as a laboratory plant will be greatly extended by the publication of such a text book.

Why the book is called "Regeneration" is not clearly explained, except that the growth reactions are associated with regeneration in animals. Some biologists have proposed vitalistic explanations of regeneration in animals, which Loeb would oppose with evidence drawn from Bryophyllum. Loeb was a very zealous materialist and lost no opportunity to insist upon a "mechanical explanation" of each fact, even when his suggestion was purely theoretical, as well as inadequate.

Many of the reactions of the Bryophyllum cuttings are ascribed to "flow of sap," though familiar facts of plants behavior would have suggested other influences. Thus in chapter V the sap theory is invoked to explain the formation of shoots along the lower margin of a suspended leaf, apparently without considering that partial shading or greater humidity might be re-

sponsible for more rapid development of buds from the lower growth points, while buds are not developed along the upper margin. No doubt the sap moves, even in the detached leaf-sections, and no doubt the chemical constituents of the sap are changed by the exposures and other conditions of the experiments, but until such sap movements have been demonstrated and the processes followed, the "flow of sap" formula is only a verbal explanation, like the vitalistic theories that Loeb would not tolerate.

The confusion of vegetative reproduction with regeneration may come from the failure to recognize that the plant body is metamerous, or composed of many internode individuals produced one from another. The vegetative internodes of many plants can produce roots as well as buds, so that each internode is capable of an independent existence. The internodes usually have buds or growth points only at the axils of the leaves, as Bryophyllum has also, in addition to the exceptional production of vegetative buds from the margins of the leaves.

As Loeb's experiments well illustrate, the usual result of mutilations of plant internodes is to induce the formation of new internodes, which is different from mending or redevelopment of parts of animals that have been mutilated or cut off, as when a new tail grows on a lizard. A true regeneration or mending of an injured part of a leaf is seldom observed among plants, and apparently is limited to very early stages of development. Some authorities have supposed that regeneration of leaf-tissues does not occur, but the leaves of the cotton plant, after mutilation by a peculiar disorder called tomosis, often regenerate to a notable extent.

O. F. Cook.

An Introduction to Anthropology

Rassenkunde, mit Besonderer Beruecksightingung des Deutschen Volkes, *by* Dr. Gustav Kraitschek. Pp. 142, with a map and 90 illustrations, price 60 cents, postpaid. Vienna, Burgverlag, 1924.

Dr. Kraitschek traces briefly the probable origin of man, the pre-historic races, and their migrations. He then analyzes more fully the great races of Europe, sketches their position in the European nations, and comments on their value. A final section is devoted to the Jews.

The brief section devoted to hybridization is perfunctory, and the author's mention of "the Americans, Davenport, Hurst and Pearson" shows that he is far from home in genetic literature.

The book is a glorification of the Nordic race; it will therefore appeal to some and arouse the antipathy of others. While it is not purely scientific, it forms, on the whole, a very useful and inexpensive introduction to anthropology, remarkably comprehensive in spite of its small size.

P. P.

HERITABLE CHARACTERS OF MAIZE

XX—Iojap-Striping, a Chlorophyll Defect

MERLE T. JENKINS
*U. S. Department of Agriculture**

NORMAL GREEN AND IOJAP STRIPED SEEDLINGS
Figure 20

The seeding to the left is normal green, the central and right-hand seedlings show the type of striping that has been named *iojap-striping*. This type of striping appears on all leaves, from the first seedling leaf to the top leaf of the mature plant. In this it differs from *Japonica striping*, which appears only on the later leaves.

IN A cross-fertilized species such as maize, any recessive defects which arise from time to time may be carried along indefinitely in the heterozygous condition. Dominant variations probably occur also, but deleterious ones do not accumulate, as, by their very nature, they tend to eliminate themselves. New recessive variations are likely to occur more often than old

*This investigation was conducted jointly by the Office of Cereal Investigations, Bureau of Plant Industry, and the Farm Crops Section, Iowa Agricultural Experiment Station.

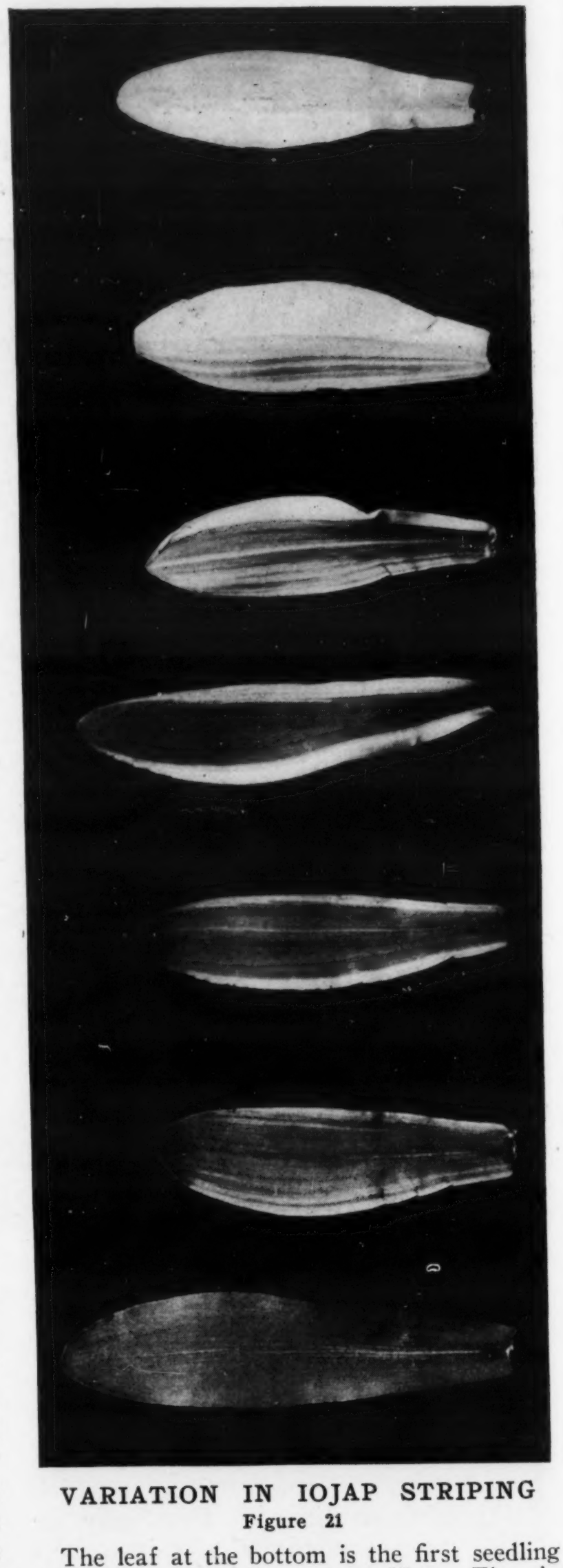
ones are lost, so that in this way there tends to be a gradual accumulation of defective types in the germ plasm of the species. A knowledge as to the number of defects present in ordinary commercial varieties of corn, therefore, is of interest for two reasons: (1) it may give some idea of the frequency with which such variations appear, and (2) it also may tell something of the physical or chemical complexity of the characters under consideration. If, for example, there are many factors affecting a single character, such as chlorophyll, it seems reasonable to suppose that its production must be dependent upon an elaborate process, in which there are many places where a slight modification may greatly change the end result.

This paper presents data on the extent to which chlorophyll defects of the seedlings and of the mature plants occurred in the progenies of maize plants self-pollinated for the first time in 1922, and on the mode of inheritance of one of these defects, which has been called *iojap striping*. The self-pollinated plants represented sixteen varieties of maize. Most of these were standard Corn Belt varieties, the self-pollinating having been done in connection with experiments on pure-line breeding.

Chlorophyll Defects in Maize

Seedling progenies were grown from 3,750 selfed† ears during the months of January to May, 1923, twenty-five seeds being planted to represent each ear. Some of these progenies were grown in the greenhouse, some in a warm basement under powerful electric lights, and the last 1,200 progenies were grown in the field in rows four feet long and twelve inches apart. Notes were taken when the plants had reached a height of four to six inches. Another twenty-five kernels from each of 2,493 of these ears were planted in the breeding plat. Here the plants were grown to maturity and notes were taken both on the seedlings and mature plants.

†Self-Pollinated.



VARIATION IN IOJAP STRIPING
Figure 21

The leaf at the bottom is the first seedling leaf from a normal green seedling. The six remaining leaves are the first seedling leaves from *iojop-striped* seedlings and show the variation in the amount of striping.

The data presented on the seedling progenies of these 2,493 ears, therefore, are based on seedlings from fifty kernels, whereas the records on the later stages are based on the mature plants from twenty-five kernels.

An additional twenty-five kernels were planted from many of the 1,257 ears that were not represented in the breeding plat, so that data for these ears also are based on the seedlings from fifty kernels. For the rest, the data were obtained on the seedlings from only twenty-five kernels. This number should be sufficient, however, to catch practically all of the defective types due to a single Mendelian factor, inasmuch as the chances are about 200 to 1 against all of the plants being normal if the progeny was segregating for a character due to a single factor.

Chlorophyll defects were found in fifteen of the sixteen varieties in which selfs were made. The numbers and percentages of progenies in the different varieties segregating for defective chlorophyll characters either as seedlings or mature plants are shown in Table I.

It will be noted that of the 3,750 progenies of which seedlings were grown, 680, or 18.1 per cent, were segregating for some type of chlorophyll defect. Most of them involved only one defective type, though some were segregating for two or even three types. The most common seedling chlorophyll variations were whites, yellows, virescent-whites, virescent-yellows, pale greens of various shades, and striped seedlings. All of these variations doubtless are similar to those reported by Hutchison[1], though whether they are due to the same genetic factors or not cannot be told.

Of the 2,493 progenies grown in the breeding plat, 152, or 6.1 per cent, were found to be segregating for some form of chlorophyll deficiency in the mature plants. Defects such as virescents and striped seedlings, which show first in the seedling stage and continue throughout the life of the plant, were recorded with the seedling defects, and were not listed again with the defects of mature plants. Among the mature plants, there were seventeen progenies segregating for *golden plants,* nine progenies segregating for *lineate leaves,* and 126 progenies segregating for various types of striped plants. In thirteen of these progenies the striping resembled *japonica striping,* in five it resembled *green-striping,* in three it resembled *yellow-striping,* and in the remaining 105 progenies the marking was confined to a few narrow stripes at the base of the leaves near the auricle.

Striped Seedlings

Variations which are apparent in the kernels or in the seedlings are by far the most desirable for use in inheritance studies with corn, as much larger numbers can be studied, and at less expense than is possible where the plants must be grown to maturity. Among the seedling variations which appeared in the experiments under consideration, the striped seedlings were the most interesting, and, for this reason, it was decided to determine the method of their inheritance.

In general, the striped seedlings had a normal green background with white or yellow stripes of different widths. There was much difference in the character of the striping in different progenies and much variation within many of the individual progenies. In some cases the stripes were very narrow, making it difficult to separate the striped seedlings from the normal green plants, whereas in other progenies the stripes were so wide as to leave but little green tissue. In the latter progenies there usually were a few all-white or all-yellow seedlings, but it is thought that these were only extreme variations of the striping character.

The striping character persists throughout the life of the plant and shows on all the leaves from the first seedling leaf to the top leaf of the mature plant. The variations in the kind of striping also persist. Thus, in some progenies the mature plants had many narrow white or yellow

TABLE I—The number and percentage of ears from maize plants self-pollinated for the first time, which produced progenies segregating for chlorophyll defects in seedlings or in mature plants

Variety	Numbers or percentages of progenies						
	From which seedlings were grown	Segregating for chlorophyll defects in seedlings		Grown to maturity	Segregating for chlorophyll defects in mature plants		Segregating for chlorophyll defects, in either stage.
		Number	Percentage		Number	Percentage	Percentage
			%			%	%
Four County	825	101	12.2	538	50	9.3	21.5
Silver King	157	22	14.0	100	12	12.0	26.0
C. I. No. 133	197	33	16.8	125	20	16.0	32.8
Iodent	898	173	19.3	593	29	4.9	24.2
C. I. No. 204	107	38	35.5	70	4	5.7	41.2
Lancaster Surecrop	392	69	17.6	255	6	2.4	20.0
Black's R. Y. Dent	148	29	19.6	99	3	3.0	22.6
Proudfit's R. Y. Dent	149	26	17.4	100	1	1.0	18.4
Kriser Bros. Y. Dent	141	29	20.6	100	0	0.0	20.6
McCulloch's R. Y. Dent	139	31	22.3	100	4	4.0	26.3
Osterland's R. Y. Dent	94	6	6.4	60	1	1.7	8.1
Clark Yellow Dent	150	26	17.3	100	6	6.0	23.3
Walden Yellow Dent	156	43	27.6	100	7	7.0	34.6
Argentine Flint	166	50	30.1	133	7	5.3	35.4
Western Flint	15	4	26.7	10	2	20.0	46.7
Rainbow Flint	16	0	0.0	10	0	0.0	0.0
ALL VARIETIES	3,750	680	18.1	2,493	152	6.1	24.2

TABLE II—The number of progenies in each of 16 varieties segregating for chlorophyll defects of seedlings, together with the number of these progenies segregating for striped seedlings

Variety	Number of progenies segregating for	
	Chlorophyll deficiencies in seedlings.	Striped Seedlings.
Four County	101	1
Silver King	22	0
C. I. No. 133	33	0
Iodent	173	154
C. I. No. 204	38	2
Lancaster Surecrop	69	10
Black's R. Y. Dent	29	3
Proudfit's R. Y. Dent	26	1
Kriser Bros. Y. Dent	29	2
McCulloch's R. Y. Dent	31	7
Osterland's R. Y. Dent	6	1
Clark Yellow Dent	26	8
Walden Yellow Dent	43	17
Argentine Flint	50	9
Western Flint	4	0
Rainbow Flint	0	0
Totals	680	215

TABLE IV—Number of segregating and non-segregating progenies grown from self-fertilized ears from normal green plants in families segregating for iojap striping.

Pedigree of parent plant.	Number of progenies	
	Non-segregating	Segregating
174-2	1	3
176-3	3	1
180-3	0	5
191-1	2	2
192-1	0	5
222-4	3	1
Totals	9	17
Expected	8.7	17.3

$\frac{\text{Deviation}}{\text{Probable Error}} = .2$

TABLE III—Number of green and non-green seedlings in progenies segregating for iojap striping grown from self fertilized ears from normal green plants

Pedigree of parent plant.	Pedigree of selfed ear.	Number of green seedlings.	Number of non-green seedlings			Deviation / Probable Error.
			Iojap	White or yellow	Total	
Original ears, grown from open-fertilized Iodent corn.	174-2	227	68			
	176-3	154	40			
	180-3	172	64	1		
	191-1	179	73			
	192-1	200	50			
	222-4	124	36			
	Sub-totals	1056	331	1	332	1.4
	Expected	1041			347	
174-2	174-2-1	196	44			
	-2	80	24			
	-5	93	30	1		
	Sub-totals	369	98	1	99	2.8
	Expected	351			117	
176-3	176-3-3	126	25	—	—	
	Sub-totals	126	25		25	3.9
	Expected	112			37	
180-3	180-3-1	170	50	4		
	-2	171	43	1		
	-3	54	18	5		
	-4	21	6			
	-5	54	17			
	Sub-totals	470	134	10	144	1.8
	Expected	461			153	
191-1	191-1-2	25	6			
	-5	34	7			
	Sub-totals	59	13	—	13	2.0
	Expected	54			18	
192-1	192-1-1	52	13			
	-2	58	23			
	-3	70	24			
	-4	127	38			
	-5	37	15			
	Sub-totals	344	113	—	113	0.2
	Expected	343			114	
222-4	222-4-5	200	81	—	—	
	Sub-totals	200	81		81	2.2
	Expected	211			70	
	Grand Totals	2624	793	12	805	3.0
	Expected	2572			857	

stripes with but little green tissue, whereas in other progenies there was a normal deep green background with a few wide white or yellow stripes. It was not possible to distinguish this last from *japonica striping. Japonica striping,* however, does not show in the seedling stage[2].

Striped seedlings were found in twelve of the sixteen varieties in which selfs were made. Table II shows the total number of progenies in each variety which were segregating for chlorophyll defects of the seedlings, together with the number of these progenies which were segregating for striped seedlings.

Iodent corn was the first variety in which striped seedlings were noted and they were by far the most common type of seedling chlorophyll variation found in this variety. Out of a total of 173 Iodent progenies segregating for seedling chlorophyll defects, 154 were segregating for striped seedlings. For this reason and because of its resemblance in many of the mature striped plants to *japonica striping,* this character has been named *iojap striping.* (Figure 20.)

Inheritance of Iojap Striping

In order to determine whether this striping was due to the same factor in all cases, a large number of crosses was made between the recessive plants in different rows. The striped plants usually are weak, however, and only six crossed ears developed. As it happened, all of these crosses were within Iodent. When kernels from these crossed ears were planted in the greenhouse they produced striped seedlings, showing that the striping in each case was due to the same factor. Crosses between plants showing *iojap* and *japonica* stripings produced only normal green plants in the F_1, showing that the factors for *iojap* and for *japonica* stripings are different.

In each progeny in which crosses of plants with *iojap striping* were made, several of the normal green plants were self-fertilized. Seedlings from the resulting ears were grown in the greenhouse, and the data recorded for the segregating progenies are presented in Table III. The all-white and all-yellow seedlings which appeared in the different progenies are shown separately, but have been included in the *iojap* class in figuring the closeness of fit to a 3:1 ratio, as it is believed that they are only extreme variations of the *iojap* character (Figure 21). If these white and yellow seedlings are not variations of the *iojap striping,* but in reality are due to a separate factor, then we should expect to find among the F_2 progenies some that are segregating for white or yellow seedlings only, with no *iojap* seedlings. No such progenies were found, and this is considered sufficient proof that the white and yellow seedlings are only extreme variations of *iojap striping.*

The data in Table III show a reasonably close fit to a 3:1 ratio. The deviation of 52 is 3.0 times its probable error. This deviation, however, is largely due to one or two progenies such as 176-3-3 where the *iojap* plants had very narrow stripes and were difficult to distinguish from the normal green seedlings.

Better evidence as to the facts may be had from a classification of the progenies, as there is no difficulty in distinguishing between a progeny that is segregating and one that is not. One-third of the green plants in families segregating for *iojap striping* should be homozygous normal, and produce green seedlings only, whereas two-thirds should be heterozygous and produce segregating progenies, when self-fertilized. In all, twenty-six self-fertilized ears were obtained from green plants in families segregating for *iojap striping.* Of these, seventeen produced progenies segregating for *iojap* seedlings and nine produced only normal green seedlings. The data on these progenies are shown in Table IV. In this case the observed data fit the expected exceedingly well.

On the basis of these data it was concluded that *iojap striping* is due to

a single factor difference and the factor pair concerned has been designated *Ij ij*.

Data also have been obtained which lead to the belief that there may be a second factor for striped seedlings. These data come from progenies which segregated both for striped seedlings and for yellow. Two distinct types of interaction were evident.

In the first case, three kinds of seedlings were obtained, as follows: Normal green, green with white stripes, green with yellow stripes.

In the second type of interaction four different kinds of seedlings occurred, as follows: Normal green, green with white stripes, pure yellow, yellow with white stripes.

At present, it is not known whether this difference was due to the action of two factors for striped seedlings or whether the same factor for striped seedlings reacted differently with two different factors for yellow.

Summary

Heritable chlorophyll variations were found to be very common in a number of standard varieties of maize from the Corn Belt and in a few varieties from other sources.

A type of seedling stripe, here called *iojap striping, Ij ij*, is shown to be inherited as a simple Mendelian recessive.

Some evidence is presented to indicate that there is either a second factor for striped seedlings or more than one factor for yellow.

Literature Cited

[1]Hutchison, C. B. Heritable Variations in Maize. *Jour. Amer. Soc. Agron.* 14:73-78. 1922.

[2]Lindstrom, E. W. Chlorophyll Inheritance in Maize. *Cornell Univ. Agr. Exp. Sta. Mem.* 13:1-68. 1918.

Study of War Problems Required

Condemning war as "a law of the jungle" and "organized revenge," the bishops (of the Methodist Church) advocated the entry of the United States into the world court.

"The church of Jesus Christ," the report read, "must never again quietly acquiesce in national or international politics which promote warlike tempers and attitude. It must do more than mildly protest. The whole strength of the united church of Christ must be thrown with compelling force against warlike policies and preparations.

"Our position must be that international warfare, unless indisputably in self-defense or defense of humanity, is a monstrosity of the pagan past which has absolutely no proper place in the program of the modern world. We respectfully remind the government of the United States that we expect the federal authorities to discover a method other than war to settle international disputes.—*Associated Press Report of Methodist General Conference.*

A "Half Mule Foot" Hog Offered for Experimental Purposes

The Experiment Station of the University of Nebraska has a pure bred Duroc Jersey boar pig, born in September, 1924, which is normal in all respects except that the two hind feet are like the feet of a "mule foot" hog. testing the heritability of this character would be of considerable interest, and since this is impossible at the Nebarska Station the pig is being offered to any responsible party who will undertake the scientific study of the inheritance of this character. As the pig will be kept only a short time longer, anyone interested in this project should take up the matter immediately with Mr. W. P. Snyder, Superintendent, University of Nebraska, North Platte, Nebraska.